

APPENDIX II

Detailed Description And Figures to: U.S. Patent Application Serial No. 09/578,947 entitled "Solutions Server" filed May 25, 2000, and incorporated herein by reference.

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Turning now to Figure 1, a first aspect of the invention is seen, a method of providing solutions to problems (12). One illustrated embodiment provides for generating problem definitions (18) for problems (12), receiving environmental information (16) required for generating solutions for the problems, generating solutions (19) for the problems
10 dependent upon the environmental information and the problem definitions, and communicating solutions (24) to clients (26) before the solutions are needed. Although the invention can be applied to a wide range of problems, in certain embodiments, the generated problem definitions are for problems related to securities trading.

15 An example embodiment, directed to generating solutions for securities trading, is shown in Figure 1A, in which generating solutions (19) is accomplished in dependence upon environmental information (10) comprising quotes (2002) from securities markets, hidden quantity ratios (2016), and latencies (2014). In many such embodiments, solutions include solution quantities calculated dependent upon quote quantities and
20 hidden quantity ratios. In many such embodiments, solutions comprise solution records sorted or indexed according to latencies for markets identified by MPIDs in the solution records. In the embodiment shown in Figure 1A, generated solutions are stored (30) in solutions records (1906) in a database (22).

25 A further embodiment shown in Figure 1 includes storing problem definitions (29) in problem definition records in a database (22). The problem definition records (314) in many embodiments are disposed in the database (22) as shown on Figure 2. An example structure for problem definition records is shown as reference (314) in Figure 2G.

A further embodiment illustrated in Figure 1 includes storing the solutions (30) in solutions records in the database (22). The solution records (316) in many embodiments are disposed in the database (22) as shown on Figure 2. An example structure for solutions records is shown as reference (316) in Figure 2F. In typical embodiments, the solutions records (316) have at least one relation (315) to the problem definition records (314), one example of which is shown on Figure 2.

A still further embodiment shown on Figure 1 includes retrieving (32) at least one solution from the solutions records in the database (22). In some embodiments illustrated by Figure 1, at least one client (26) is a broker-dealer computer system programmed and operated to effect securities trading.

Some embodiments illustrated by Figure 1, when received environmental information (10) changes, include generating additional solutions (19) dependent upon the changed environmental information and the problem definitions and communicating (24) additional solutions to clients before the additional solutions are needed. In many embodiments, problems are categorized according to type, an example of which is the use of the probdeftype field (202) in the problem definition structure (314) shown in Figure 2G.

In a still further embodiment, as shown on Figure 1, the invention includes generating subscriptions (20) for solutions, the subscriptions comprising relations between clients and types of problems. An example of an embodiment implementing a relation between clients and types of problems is the subscription structure (310) in Figure 2D, where the subscription comprises data elements identifying a client (216) and a problem type (202).

Referring to Figure 3, a still further embodiment of the invention is seen. One embodiment shown in Figure 3 includes submitting (302) a request (304) for a subscription. A still further embodiment illustrated at Figure 3 provides for creating

(308) a subscription record (310) in response to the submission (302) of the request (304) for a subscription. A typical example of a subscription record (310), shown at Figure 2D, comprises data elements identifying a client (216) and a problem type (202).

5 A still further embodiment illustrated at Figure 3 provides for creating (312) at least one problem definition (314) record dependent upon problem definition rules (306). An example problem definition data structure used in many embodiments directed to securities trading is illustrated in Figure 2G as comprising problem definition type (202), side (208), symbol (210), and quantity (226). An example problem definition rule
10 structure used in many embodiments directed to securities trading is illustrated in Figure 2B as comprising problem definition type (202) and quantity (204).

Turning now to Figure 4, a further embodiment of the invention is seen. One embodiment illustrated at Figure 4 includes receiving environmental information which
15 in the illustrated embodiment comprises market information (402) in the form of quotes (28), the quotes (28) comprising data elements representing side (208), symbol (210), quantity (212), market (206), and a tag (214) as shown in Figure 2C. The tag (214) is an indication of the status of the quote, including, for example, whether the quote is an open quote or a closed quote.

20 In a further embodiment illustrated at Figure 4, the invention provides, when a quote is received and the quote tag does not indicate (413) that the quote is closed, finding a problem definition record (404) having the same side and symbol as the quote. In a still further embodiment shown in Figure 4, the invention provides for searching for a solution
25 record (408) having the same problem type, side, and symbol as the problem definition record having the same side and symbol as the quote and the same market as the quote.

When the solution record is found (409), the illustrated embodiment includes updating the solution record (410) with the price from the quote. When the solution record is not

found (411), the illustrated embodiment includes creating a new solution record (412) having the same problem type, side, and symbol as the problem definition record having the same side and symbol as the quote, the same market as the quote, and the same price as the quote. When a quote is received and the quote tag indicates that the quote is closed
5 (415), the illustrated embodiment includes deleting (414) solution records having the same side, symbol, and market as the quote.

An additional example embodiment, directed to solutions for securities trading, is shown in Figure 4A, in which creating solutions (412) is accomplished in dependence upon
10 quotes (2002) from securities markets, hidden quantity ratios (2016), and latencies (2014). In many such embodiments, solutions include solution quantities calculated dependent upon quote quantities and hidden quantity ratios. In many such embodiments, solutions comprise solution records sorted or indexed according to latencies for markets identified by MPIDs in the solution records. In the embodiment shown in Figure 4A,
15 generated solutions are stored (30) in solutions records (1906) in a database (22).

Turning to Figure 5, a still further embodiment of the invention is seen. One embodiment shown in Figure 5 includes repeatedly finding (502) a subscription record so that each existing subscription record (310) is found in turn. When a subscription record (504) is
20 found, the illustrated embodiment includes finding (508), for each found subscription record (510), a related record of data communications parameters (516) for the client identified in the found subscription record (504).

For each found subscription record (504), the illustrated embodiment includes finding
25 (506) at least one related problem definition record (510). When at least one problem definition record (510) is found, the embodiment of Figure 5 includes finding (512), for each found problem definition record (510), at least one related solution record (514). A still further embodiment, as shown on Figure 5, provides for communicating (518, 520), dependent upon data communication parameters identified in the found record of data

communications parameters (516), to the client (26) identified in the found subscription record (504) at least one data element of the found solution record (514).

Turning to Figure 6, still further embodiments of the invention are seen. One embodiment illustrated at Figure 6 includes communicating solutions (24) to clients as communicating solutions to an order processing system (26) on a broker-dealer computer. A further embodiment shown on Figure 6 includes receiving (604) at least one customer order (606). The customer order, illustrated in detail at reference 606 on Figure 2H, comprises data elements identifying symbol (210), quantity (228), and optionally, price (230), market (224), and order type (226). In many embodiments, the customer order type has a relation to a problem type. Problem types as used in typical embodiments are illustrated at reference (202) in solution structure (316) on Figure 2F. A still further embodiment illustrated in Figure 6 includes finding (608) at least one solution record (610) having the same symbol (210) as the received customer order (606) and also having a problem type related to the customer order type (226) in the received customer order (606).

A still further embodiment illustrated in Figure 6 includes sending (612) to at least one market (614) at least one solution order (616), the solution order being dependent upon the customer order and the data in the found solution record (610). A still further embodiment illustrated in Figure 6 includes sending (612) to at least one market (614) at least one solution order (616), the solution order comprising the side, symbol, quantity, price, and market data elements from the found solution record (610).

Turning to Figure 7, a further aspect of the invention is seen, that is, a system (702) for providing solutions to problems. One embodiment shown in Figure 7 includes means for generating problem definitions (704) for problems, means for receiving environmental information (706) required for generating solutions for the problems, means for generating solutions (708) for the problems dependent upon the environmental

information and the problem definitions, and means for communicating solutions (710) to clients before the solutions are needed.

The means for generating problem definitions (704) in typical embodiments is a
5 computer programmed to store problem definitions in a data structure in computer
memory. An example of such a data structure is provided at reference (314) in Figure
2G. The means for receiving environmental information (706) in typical embodiments is
a computer programmed to receive a data stream through a data communications port,
typically, not always, connected to a network. An example of such a data stream is a
10 Nasdaq feed, a stream of ticker information or quotes provided to subscribers by Nasdaq.

The means for generating solutions (708) for the problems dependent upon the
environmental information and the problem definitions in typical embodiments is a
computer programmed to generate and store solutions in a data structure in computer
15 memory. An example of such a data structure is provided at reference (316) in Figure 2F.

The means for communicating solutions (710) to clients before the solutions are needed,
in typical embodiments, is a computer programmed to retrieve solutions from computer
memory and transmit through a communications port, often over networks, to clients. In
20 other embodiments, at least one of the clients is closely coupled to the system for
providing solutions, with communicating solutions structured through shared memory,
software subroutine calls, or calls to member functions in class objects.

In some embodiments clients (712) are implemented in the same overall computer system
25 (702) as the system (702) for providing solutions to problems. Other embodiments have
clients (714) as separate entities. Still other embodiments have other relations between
the system for providing solutions and clients, all which relations are within the scope of
the present invention.

In some embodiments implemented as shown in Figure 7, the problem definitions are for problems related to securities trading. A further embodiment provides means for storing the problem definitions (716) in problem definition records in a database (22).

5 A still further embodiment provides means for storing the solutions (718) in solutions records in the database (22). The means for storing the problem definitions and means for storing solutions, in the illustrated embodiment, is computer memory coupled to a processor. The computer memory has various forms in various embodiments, including random access memory, magnetic disk drives, read only memory, programmable read
10 only memory, and erasable programmable read only memory. Means for storing takes many forms in computer memory, all within the scope of the invention.

In many embodiments, the solutions records have at least one relation to the problem records, for example, one-to-many or many-to-many. Other relations are used in other
15 embodiments, all within the scope of the invention. A still further embodiment provides means for retrieving at least one solution (720) from the solutions records in the database. Means for retrieving in typical embodiments is a computer processor coupled to computer memory and programmed to search the memory. In some embodiments, at least one client (712, 714) is a broker-dealer computer system programmed and operated
20 to effect securities trading.

A still further embodiment illustrated on Figure 7 provides for use when received environmental information changes means for generating additional solutions (722) dependent upon the changed environmental information and the problem definitions and
25 means for communicating additional solutions (724) to clients before the additional solutions are needed. In many embodiments of the kind illustrated on Figure 7, problems are categorized according to type.

A still further embodiment shown in Figure 7 provides means for generating subscriptions (726) for solutions, the subscriptions comprising relations between clients and types of problems. Means for generating subscriptions in such embodiments include available data entry screens for entering data into a computer, the data being received by
5 a computer processor capable of storing the subscriptions in computer memory.

Turning now to Figure 8, a further aspect of the inventions is seen. Figure 8 shows an embodiment providing means for submitting a request (804) for a subscription. Means for submitting a request for a subscription in such embodiments include available data
10 entry screens for entering data into a computer, the data being received by a computer processor capable of storing the subscriptions in computer memory.

A further embodiment shown on Figure 8 provides means for creating (806) a subscription record in response to the submission of the request for a subscription.
15 Means for creating a subscription record in such embodiments include a computer processor programmed to create and store the subscription record in computer memory. In many such embodiments, the subscription record comprises data elements identifying a client and a problem type.

20 A still further embodiment shown on Figure 8 provides means for creating (808) at least one problem definition record dependent upon problem definition rules. Means for creating a problem definition record in such embodiments include a computer processor programmed to read rules from a computer memory store of problem definition rules and create and store a problem definition record in computer memory. In many such
25 embodiments, the problem record comprises data elements identifying problem type, side, symbol, and quantity.

Turning now to Figure 9, a further embodiment of the invention is seen. An embodiment shown in Figure 9 provides means for receiving environmental information comprising

means for receiving (904) market information in the form of quotes, the quotes typically comprising, as shown in figure 2C, data elements of side (208), symbol (210), quantity (212), market (206), and a tag (214), the tag being a status code for the quote. Means for receiving market information, in embodiments similar to the ones illustrated in Figure 9,
5 include ticker feeds, quote feeds, and market data feeds from Nasdaq and from other exchanges, as well as similar feeds from ECNs, market makers, other markets, and other broker-dealers.

A further embodiment of the invention, shown on Figure 9, provides, for use when a
10 quote is received and the quote tag does not indicate that the quote is closed, means for finding (906) a problem definition record having the same side and symbol as the quote. Means for finding a problem definition record in such embodiments include a computer processor programmed to search through problem definition records in a table or database using established search criteria.

15 A further embodiment of the invention, shown on Figure 9, provides means for searching (908) for a solution record having the same problem type, side, and symbol as the problem definition record having the same side and symbol as the quote and the same market as the quote. Means for searching for a solution record in such embodiments
20 include a computer processor programmed to search through solution records in a table or database using established search criteria.

A further embodiment, shown on Figure 9, provides, for use when a solution record is found, means for updating (910) the solution record with the price from the quote.
25 Means for updating the solution record, in many such embodiments, is a computer processor programmed to write the updated price into a price field or data element in the solution record, data structure, or class object in computer memory.

A further embodiment, shown on Figure 9, provides, for use when the solution record is not found, means for creating (912) a new solution record having the same problem type, side, and symbol as the problem definition record having the same side and symbol as the quote, the same market as the quote, and the same price as the quote. In such

5 embodiments, means for creating a new solution record typically comprise a computer processor programmed to create a data structure having defined data elements and write into those data elements the information from the quote and the problem definition record. An example of such a data structure is shown at reference 316 on Figure 2F. The example of Figure 2F is directed to solutions for problems of securities trading and
10 includes data elements of problem type (202), side (208), symbol (210), quantity (220), price (222), and market identification code (224).

A still further embodiment shown on Figure 9 provides, for use when a quote is received and the quote tag indicates that the quote is closed, means for deleting (914) solution
15 records having the same side, symbol, and market as the quote. Means for deleting solution records in such embodiments include a computer processor programmed to search through solution records in a table or database using established search criteria, locate records meeting the criteria, and delete those records from the table or database, or alternatively, mark the records as not in use.

20 Turning now to Figure 10, a further embodiment is seen to provide means for repeatedly finding (1004) a subscription record so that each existing subscription record is found in turn. Means for repeatedly finding a subscription record in such embodiments include a computer processor programmed to search through subscription records in computer
25 memory, said computer memory including, in various embodiments, arrays, linked lists, linked lists of pointers to other structures, tables, and databases.

A still further embodiment, shown on Figure 10, provides means for finding (1006), for each found subscription record, a related record of data communications parameters for

the client identified in the found subscription record. Means for finding a related record of data communications parameters in such embodiments include a computer processor programmed to search through records of data communications parameters in computer memory, said computer memory including, in various embodiments, arrays, linked lists, linked lists of pointers to other structures, tables, and databases.

A still further embodiment, shown on Figure 10, provides means for finding (1008), for each found subscription record, at least one related problem definition record. Means for finding a related problem definition record in such embodiments include a computer processor programmed to search through problem definition record in computer memory, said computer memory including, in various embodiments, arrays, linked lists, linked lists of pointers to other structures, tables, and databases.

A still further embodiment, shown on Figure 10, provides, for use when at least one problem definition record is found, means for finding (1010), for each found problem definition record, at least one related solution record. Means for finding a related solution record in such embodiments include a computer processor programmed to search through solutions records in computer memory, said computer memory including, in various embodiments, arrays, linked lists, linked lists of pointers to other structures, tables, and databases.

A still further embodiment, shown on Figure 10, includes means for communicating (1012), dependent upon data communication parameters identified in the found record of data communications parameters, to the client identified in the found subscription record at least one data element of the found solution record. Means for communicating data from a solution record in such embodiments include data communications ports, networks, satellite links, dedicated phone lines, intranets, internets, and extranets coupling the search processor to at least one client.

Turning now to Figure 11, further embodiments of the invention are seen. Figure 11 shows one embodiment providing means for communicating solutions to clients further comprising means for communicating (1104) solutions to an order processing system on a broker-dealer computer. Means for communicating data from a solution record in such
5 embodiments include data communications ports, networks, satellite links, dedicated phone lines, intranets, internets, and extranets coupling the search processor to at least one broker-dealer computer.

A further embodiment shown on Figure 11 provides means for receiving (1106) at least
10 one customer order. The means for receiving an order in such embodiments typically includes customer workstations coupled to an order processing system, the coupling effected typically through data communications ports, networks, satellite links, dedicated phone lines, intranets, internets, and extranets coupling the search processor to at least one broker-dealer computer.

15 In such embodiments, the customer order typically comprises data elements identifying symbol (210), quantity (228), and optionally, price (230), market (224), and order type (226), as shown on Figure 2H. In many embodiments of the invention as it relates to processing systems for securities, the customer order type has a relation to a problem
20 type, including, for example, the order type having a one to one correspondence with a problem type. All relations between order type and problems type are within the invention.

A further embodiment, shown on Figure 11, provides means for finding (1108) at least
25 one solution record having the same symbol as the received customer order and also having a problem type related to the customer order type in the received customer order. Means for finding at least one solution record in such embodiments includes a computer processor programmed to search through solutions records in computer memory, said computer memory including, in various embodiments, arrays, linked lists, linked lists of

pointers to other structures, tables, and databases.

A still further embodiment, shown on Figure 11, provides means for sending (1110) to at least one market at least one solution order, the solution order being dependent upon the customer order and the data in the solution record. Means for sending the solution order in such embodiments include data communications ports, networks, satellite links, dedicated phone lines, intranets, internets, and extranets coupling the search processor to at least one market.

A still further embodiment, shown on Figure 11, provides means for sending (1112) to at least one market at least one solution order, the solution order comprising the side, symbol, quantity, price, and market data elements from the found solution record. Means for sending the solution order in such embodiments include data communications ports, networks, satellite links, dedicated phone lines, intranets, internets, and extranets coupling the search processor to at least one market.

Turning to Figure 12, a further aspect of the invention is seen, that is, a solutions server. One embodiment of a solutions server, illustrated at Figure 12, includes a processor (36) coupled to at least one source of environmental information (10) and coupled also to at least one client (26). The processor (36) is programmed, in one embodiment illustrated in Figure 14, to generate problem definitions (1304) for problems, receive environmental information (1302) required for generating solutions for the problems, generate solutions (1306) for the problems dependent upon the environmental information and the problem definitions, and communicate solutions (1308) to clients before the solutions are needed. The solutions server of Figure 12 includes also a memory (32) coupled to the processor (36), the processor being programmed also to store (1310) in the memory problem definitions and solutions. Although the solutions server aspect of the invention is useful for many different kinds of problems, many embodiments of the illustrated solutions

server include problem definitions and solutions related to securities trading.

A further embodiment of the solutions server of Figure 14 includes computer memory (32) in which is stored (1310) problem definitions and solutions. Many embodiments of the solutions server implement computer memory storing problem definitions in the form of a database (22) with problem definitions records in a table (314) as shown in Figure 2. An example of problem definitions records structured to address problems of securities trading is shown in Figure 2G as including data elements of problem type (202), side (208), symbol (210), quantity (226). An example of solutions records structured to address problems of securities trading is shown in Figure 2F as including data elements of problem type (202), symbol (210), side (208), quantity (220), price (222), and market identification (224).

A further embodiment illustrated at Figure 14 provides a processor (36) further programmed to retrieve (1312) at least one solution record from the solutions records in the database (22). In many embodiments of the aspect of the invention illustrated in Figure 14, at least one client (26) is a broker-dealer computer system programmed and operated to effect securities trading.

In many embodiments of the solutions server illustrated in Figure 12 and 14, problems are categorized according to type. An example of a data structure (314) defining a problem categorized according to problem type (202) is shown at Figure 2G.

A further embodiment illustrated at Figure 14 provides a processor (36) further programmed to generate subscriptions (1314) for solutions. In many embodiments of the kind illustrated, subscriptions comprise relations between clients (216) and types of problems (202) as shown in data structure (310) in Figure 2D.

Turning to Figure 15, additional embodiments of a solution server are seen. One embodiment shown in Figure 15 provides for a client's (26) submitting to a processor (36) a request for a subscription (1402). Another embodiment shown on Figure 15 provides the processor (36) programmed to create a subscription record (1404) in response to the submission (1402) of the request for a subscription. In some embodiments, for example, the subscription record (310) comprises data elements identifying a client (216) and a problem type (202) as shown on Figure 2D.

Still another embodiment illustrated on Figure 15 provides the processor (36) further programmed to create (1406) at least one problem definition record dependent upon problem definition rules. In some embodiments, for example, the problem definition record (314) comprises data elements identifying problem type (202), side (208), symbol (210), and quantity (226), as shown in Figure 2G.

Turning to Figure 16, further embodiments of a solution server are seen. Figure 16 illustrates an embodiment directed to securities trading in which environmental information comprises market information in the form of quotes received (1502) by a processor (36). An example of a data structure useful for this class of quotes (28), the quotes further comprising data elements identifying side (208), symbol (210), quantity (212), market (206), and a tag (214), is shown at Figure 2C.

A further embodiment of the solutions server, shown in Figure 16, provides the processor being further programmed to find (1504), when a quote is received (1502), a problem definition record having the same side and symbol as the quote. A further embodiment of the solutions server, shown in Figure 16, provides the processor further programmed to search (1506) for a solution record having the same problem type, side, and symbol as the problem definition record having the same side and symbol as the quote and the same market as the quote. A still further embodiment of the solutions server, shown in Figure 16, provides the processor being further programmed to update (1508), when the solution

record is found, the solution record with the price from the quote.

A further embodiment of the solutions server, shown in Figure 16, provides the processor further programmed to create a new solution record (1510), when the solution record is not found, having the same problem type, side, and symbol as the problem definition record having the same side and symbol as the quote, the same market as the quote, and the same price as the quote. A further embodiment of the solutions server, shown in Figure 16, provides the processor further programmed to delete (1512) solution records having the same side, symbol, and market as the quote, when a quote is received and the quote tag indicates that the quote is closed.

Turning now to Figure 17, additional embodiments of a solutions server are seen. One embodiment illustrated in Figure 17 provides a processor programmed to repeatedly find (1602) a next subscription record so that each existing subscription record is found in turn.

A further embodiment shown in Figure 17 provides the processor further programmed to find (1604), at least one subscription record is found, for each found subscription record, a related record of data communications parameters for the client identified in the found subscription record. A further embodiment shown in Figure 17 provides the processor further programmed to find (1606), for each found subscription record, at least one related problem definition record.

A still further embodiment shown in Figure 17 provides the processor further programmed to find (1608), when at least one problem definition record is found, for each found problem definition record, at least one related solution record. A further embodiment shown in Figure 17 provides the processor further programmed to communicate (1610), dependent upon data communication parameters identified in a found record of data communications parameters, to the client identified in the found

subscription record at least one data element of a found solution record.

Turning to Figure 18, further embodiments of the invention are seen. One embodiment illustrated in Figure 18 provides a solutions server processor (5) is programmed to

5 communicate solutions (1704) to clients, the processor (5) programmed to communicate (1704) solutions (316) to at least one order processing system (1708) on a broker-dealer computer (1706), the broker-dealer computer (1706) further comprising a broker-dealer processor (1702).

10 A further embodiment shown in Figure 18 provides the broker-dealer processor (1702) programmed to receive (1710) at least one customer order (1720). In some embodiments the order processing system is the client (26) as shown on Figure 12. In embodiments of the kind shown in Figure 12, the client order processing system is installed and operated on a computer (28) separate from the computer (30) on which the solution server (5) is
15 installed. In other embodiments, as shown in Figure 13, the client order processing system (26) is installed and operated on the same computer (30) with the solution server (5). All these embodiments, as well as other configurations of solution server and client installation and operation, are well within the scope of the present invention.

20 In some embodiments, the customer order (606) comprises data elements identifying symbol (210), quantity (228), and optionally, price (230), market (224), and order type (226), as shown in Figure 2H. Other embodiments use other data structures for orders, all structures for order being well within the scope of the present invention.

25 In many embodiments, the customer order type (226) has a relation (as shown, for example, at reference number 1728 on Figure 18) to a problem type (1712), including, for example, a one-to-one correspondence. All relations between order type and problem type are within the scope of the present invention.

A still further embodiment shown in Figure 18 provides the broker-dealer processor (1702) further programmed to find (1714) at least one solution record (1722) dependent upon the received customer order and, in many embodiments, also dependent upon having the problem type (1712).

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A still further embodiment shown in Figure 18 provides the broker-dealer processor (1702) further programmed to create (1724) and send (1716) to at least one market (614) at least one solution order (1726) dependent upon the customer order (1720) and the found solution record (1722). Solution orders (1726) in many embodiments have structures dictated by the markets to which the solution orders are directed, although in many embodiments, the structure of solution orders is similar to the structure of the customer order as shown in Figure 2H. All data structures useful for solutions orders sent to markets are well within the invention. Typical embodiments of the kind illustrated in Figure 18 provide the broker-dealer processor (1702) programmed to send (1716) to at least one market (614) at least one solution order (1726), the solution order comprising the side, symbol, quantity, price, and market data elements from the found solution record.

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Turning now to Figure 19, a further aspect of the invention is seen, that is, a method of providing solutions for trading securities. One embodiment illustrated at Figure 19 includes receiving a level-two quote (2002), the level-two quote comprising a symbol (2010) and at least one market participant quote (2004), the market participant quote further comprising a quote price (2006), a quote quantity (2008), a quote MPID (2012), and a quote side (2012). The illustrated embodiment includes creating (1904) in computer memory a solution set (1902) comprising at least one solution record (1906) corresponding to each market participant quote (2004) in the level-two quote (2002), the solution record (1906) comprising a solution symbol (1908), a solution side (1916), a solution MPID (1918), a solution price (1920), a solution quantity (1922), and a solution latency (1924), the solution latency comprising a latency for the market identified by the

solution MPID (1918). A further embodiment shown also in Figure 19 includes sending (1928) the solution set to at least one client (1930).

It is worth noting that embodiments of the kind illustrated in Figure 19 do not include
5 problem definitions in the form of data structures stored in records or tables in databases. In these embodiments, problem definitions typically take, for example, forms such as “Buy MSFT” or “Sell GMC,” that is, a side combined with a symbol. In embodiments using such problem definitions, comprising as they do merely a side and a symbol, the software programs stored in memory and controlling a processor can be designed to infer
10 problem definitions with no need for separate storage of problem definitions in a database. In such embodiments, specific problem definitions are inferred from the client’s presentation of the problem. For example, in the case of securities trading, a customer order includes a side and a symbol. If the order side is “bid” and the order symbol is “MSFT,” then the problem definition is inferred to be “Buy MSFT.” The
15 client software in such embodiments proceeds directly to a search of the solutions records based on merely those two fields, side and symbol, to find solutions to the problem of “Buy MSFT.”

In a further embodiment, as shown in Figure 21, the client (1930) comprises an
20 automated system for trading securities, and the embodiment includes storing (2102) the sent solution set (2104) in computer memory (2106) in the client system (1930). The embodiment illustrated in Figure 21 also provides for using (2114) at least one of the sent solution records (2104) to create (2108) orders (2112) for securities. The embodiment of Figure 21 also includes deleting (2110) from computer memory the used solution records
25 (2116).

In a further embodiment, shown in Figure 22, the client (1930) comprises more than one automated system (2204) for trading securities and the automated systems for trading securities are scaled. “Scaled” means that solutions provided to clients are apportioned

for efficiency among more than one client computer system. In the embodiment shown in Figure 22, for example, solutions for symbols beginning with the letters of the alphabet between "A" and "C" are sent to a first client system (2206), and solutions for symbols beginning with letters in other ranges are apportioned among other client systems (2208, 2210).

In a further embodiment, referring again to Figure 19, creating (1904) a solution set is seen to further comprise recording (1908) in the solution record (1906) the solution side (1916) derived from the quote side (2012), the solution MPID (1918) derived from the quote MPID (2010), the solution price (1920) derived from the quote price (2000), and the solution symbol (1908) derived from the symbol (2010) in the level-two quote (2002).

In a still further embodiment, also shown in Figure 19, creating (1904) a solution set includes calculating (1910) the solution quantity (1922) for the solution record (1906) dependent upon the quote quantity (2008) and dependent upon a hidden quantity ratio (2016) for the market identified by the solution MPID (1918). This embodiment also provides for recording (1940) the solution quantity (1922) in the solution record (1906).

In a further embodiment of the invention, illustrated at Figure 23, the hidden quantity ratio (2016) comprises a running average (2302) of the ratios (2304) of order fill quantity (2316) to quote quantity, the order fill quantity and the quote quantity being derived from trade data (2322) comprising descriptions of executions of orders for securities.

In a still further embodiment of the invention, illustrated at Figure 23, the hidden quantity ratio (2016) comprises a ratio (2304) of an order fill quantity to a quote quantity, the order fill quantity and the quote quantity being derived from trade data comprising descriptions of executions of orders for securities.

In a further embodiment, illustrated also in Figure 19, the solution set comprises at least two solution records, and the illustrated embodiment includes sorting (1932) the solution records (1906) to yield sorted solution records (1934). Some embodiments sort

according to side. Other embodiments sort according to price, latency, price and latency, or side and price and latency. Still other embodiments utilize other sorting principles, all sorting arrangement being well within the scope of the invention.

5 A further embodiment, shown also in Figure 19, provides for deleting (1936) solution latency from the sorted solution records (1934). A further embodiment, also shown on Figure 19, include creating (1950) an index (1952) for use in accessing (1954) solution records (1906) in the solution set (1902). Some embodiments index according to side. Other embodiments index according to price, latency, price and latency, or side and price
10 and latency. All forms of index are well within the scope of the invention.

In a further embodiment of the invention, as shown in Figure 19, the solution record (1906) further comprises a type code (1926).

In a still further embodiment of the invention, as shown in Figure 20A, latency (2014)
15 comprises the difference between the time when a broker-dealer (2018) receives (2024) from a market (2020) a response to an order and the time when the order was sent (2022) to the market. Other embodiments measure latency according to the time for the order to travel from the broker-dealer to the market. Other embodiments measure latency according to the fill time within the market. All measures of latency as used in various
20 embodiments are well within the scope of the invention.

Turning now to Figure 24, a further aspect of the invention is seen, that is, a system for generating solutions for trading securities. In one embodiment, shown in Figure 24, a system (2402) for generating solutions for trading securities includes means for receiving
25 (2402) a level-two quote (2002), the level-two quote comprising a symbol and at least one market participant quote (2005), the market participant quote further comprising a quote price (2006), a quote quantity (2008), a quote MPID (2010), and a quote side (2012). Means for receiving a level-two quote includes Nasdaq feeds and subscriber feeds from ECNs received across networks or dedicated lines through communications

ports operated under program control in a computer system. Other sources of feeds for level-two quotes are within the scope of the invention, including dedicated communications hardware which in some cases is supplied by the sources of quotes for the purpose of communicating quotes, including, for example, Nasdaq's "Service
5 Delivery Platform" or "SDP."

The embodiment illustrated in Figure 24 includes also means for creating (2406) in computer memory (2408) a solution set (1902) comprising at least one solution record (1906) corresponding to each market participant quote (2005) in the level-two quote
10 (2002), the solution record (1906) comprising a solution symbol (1908), a solution side (1916), a solution MPID (1918), a solution price (1920), a solution quantity (1922), and a solution latency (1924), the solution latency comprising a latency for a market identified by the solution MPID (1918). Means for creating a solution set in computer memory, in most embodiments, is a computer processor coupled to computer memory and operating
15 under control of a program stored in computer memory. Forms of computer memory operable within the invention include random access memory, read-only memory, programmable read-only memory, erasable programmable read-only memory, other forms of semiconductor memory, as well as various forms of magnetic storage such as computer disk drives.

The embodiment illustrated in Figure 24 also includes means for sending (2410) the solution set to at least one client (1930). Means for sending the solution in such
20 embodiments includes data communications ports, networks, satellite links, dedicated phone lines, intranets, internets, extranets, and other forms of networks, coupling the
25 embodiment of the invention to at least one client.

In a further embodiment, shown in Figure 25, the client (1930) comprises an automated system for trading securities that includes means for storing (2502) the sent solution set (1902) in computer memory (2504) in the client (1930). Means for storing a solution set

in computer memory, in most embodiments, is a computer processor coupled to computer memory and operating under control of a program stored in computer memory. Forms of computer memory operable within the invention include random access memory, read-only memory, programmable read-only memory, erasable programmable read-only
5 memory, other forms of semiconductor memory, as well as various forms of magnetic storage such as computer disk drives.

The embodiment illustrated in Figure 25 includes also means for creating (2506), from at least one of the sent solution records (1902), an order (2508) for securities, wherein
10 creating an order from the sent solution record (1902) further comprises creating (2512) a used solution record (2510). Means for creating an order, in most embodiments, is a computer processor coupled to computer memory and operating under control of a program stored in computer memory.

15 The embodiment illustrated in Figure 25 also provides means for deleting (2514) from computer memory (2504) the used solution record (2510). Means for deleting the used record, in most embodiments, is a computer processor coupled to computer memory and operating under control of a program stored in computer memory. Forms of computer memory operable within the invention include random access memory, read-only
20 memory, programmable read-only memory, erasable programmable read-only memory, other forms of semiconductor memory, as well as various forms of magnetic storage such as computer disk drives.

In a further embodiment, as shown in Figure 22, the client (1930) includes more than one
25 automated system (2204) for trading securities and the automated systems (2204) for trading securities are scaled. "Scaled" means that solutions provided to clients are apportioned for efficiency among more than one client computer system. In the embodiment shown in Figure 22, for example, solutions for symbols beginning with the

letters of the alphabet between “A” and “C” are sent to a first client system (2206), and solutions for symbols beginning with letters in other ranges are apportioned among other client systems (2208, 2210).

5 In a further embodiment, shown in Figure 24, means for creating a solution set includes means for recording (2412) in the solution record, as shown in more detail in Figure 29, the solution side (1916) derived from the quote side (2012), the solution MPID (1918) derived from the quote MPID (2010), the solution price (1920) derived from the quote price (2006), and the solution symbol (1908) derived from the symbol (2004) in the level-
10 two quote. Means for recording in the solution record, in most embodiments, is a computer processor coupled to computer memory and operating under control of a program stored in computer memory.

In a further embodiment of the invention illustrated in Figure 24 the means for creating a
15 solution set includes means for calculating (2414) the solution quantity for the solution record dependent upon the quote quantity and dependent upon a hidden quantity ratio for the market identified by the solution MPID. Means for calculating the solution quantity, in most embodiments, is a computer processor coupled to computer memory and operating under control of a program stored in computer memory.

20 In the embodiment illustrated in Figure 24, the means for creating a solution set includes means for recording (2416) the solution quantity in the solution record. Means for calculating the solution quantity and means for recording the solution quantity, in most embodiments, are a computer processor coupled to computer memory and operating
25 under control of a program stored in computer memory.

In a further embodiment of the invention, as shown in Figure 23, the hidden quantity ratio (2016) comprises a running average (2302) of the ratios (2304) of order fill quantity (2316) to quote quantity (2318), the order fill quantity and the quote quantity being

derived from trade data (2322) comprising descriptions of executions of orders for securities. In a still further embodiment of the invention, also shown in Figure 23, the hidden quantity ratio (2016) comprises a ratio (2304) of an order fill quantity (2316) to a quote quantity (2318), the order fill quantity and the quote quantity being derived from
5 trade data (2322) comprising descriptions of executions of orders for securities.

In a further embodiment of the invention, as shown in Figure 24, the solution set (1902) includes at least two solution records (1906), and the embodiment further includes means for sorting (2418) the solution records to yield sorted solution records (1934). A further
10 embodiment, as shown in Figure 24, includes means for sorting the solution records according to side. Other embodiments includes means for sorting the solution records according to price, latency, price and latency, side and price and latency. Other embodiments sort according to other fields or combinations of fields within the solution records. All sorting arrangements of the solution records, in various alternative
15 embodiments, are well within the scope of the invention. Means for sorting solution records, in most embodiments, is a computer processor coupled to computer memory and operating under control of a program stored in computer memory.

A further embodiment, also shown in Figure 24, provides means for deleting (2420)
20 solution latency from the sorted solution records (1934). Means for deleting in most embodiments is at least one computer processor operating under control of a program stored in computer memory.

A further embodiment, also shown in Figure 24, includes means for creating (2422) an
25 index for the solution set. Means for creating an index in most embodiments is at least one computer processor operating under program control to read index fields from the solution records and create a new set of ordered index records in computer memory dependent upon the read fields. Indexes so created are ordered according to side, price,

latency, price and latency, side and price and latency, and other ordering principles, all of which in various alternative embodiments are well within the scope of the invention.

In a further embodiment of the invention, shown in Figure 24, the solution record (1906) includes a type code (1926). In many embodiments, the type code (1926) is used to select among computer program subroutines to vary the function of the invention to provide solutions optimizing speed of order execution, solutions optimizing price, solution optimizing quantities of securities traded, and quantities optimizing other parameters of performance. Many such solutions are effected by use of various sorting principles applied to solution records in computer memory.

In a further embodiment of the invention, shown in Figure 20A, solution latency (1924) comprises the difference between the time (2018) when a broker-dealer (2024) receives from a market (2020) a response to an order and the time when the order was sent (2022) to the market (2020). Other embodiments measure latency according to the time for the order to travel from the broker-dealer to the market. Other embodiments measure latency according to the fill time within the market. All measures of latency as used in various embodiments are well within the scope of the invention.

Turning now to Figure 26, a further aspect of the invention is seen as a system (2602) for providing solutions for trading securities. One embodiment, illustrated in Figure 26, provides a processor (2604) coupled (2610) to at least one source of quotes (2606) and coupled (2612) to at least one client (1930), the processor (2604) programmed to receive (2608) at least one level-two quote (2002), the level-two quote (2002) comprising a symbol and at least one market participant quote (2004), the market participant quote comprising a quote price (2006), a quote quantity (2008), a quote MPID (2010), and a quote side (2012).

A further embodiment illustrated in Figure 26 includes the processor programmed to create (2614) a solution set (1902) comprising at least one solution record (1906) corresponding to each market participant quote (2004), the solution record comprising a solution symbol (1908), a solution side (1906), a solution MPID (1918), a solution price (1920), a solution quantity (1922), and a solution latency (1924), the solution latency comprising a latency for the market identified by the solution MPID (1918). The embodiment illustrated in Figure 26 includes also a memory (2618) coupled (2620) to the processor (2604) with the processor programmed to store (2616) the solution set (1902) in the memory (2618).

10 A further embodiment illustrated in Figure 26 includes the processor the processor (2604) is programmed to send (2622) the solution set (1902) to the client (1930).

In a further embodiment, shown in Figure 27, the client (1930) comprises an automated system for trading securities, the system further comprising a client processor (2702) coupled to client memory (2704). In the embodiment shown in Figure 27, the client processor is programmed to store (2706) the sent solution set (1902) in client memory (2704), create (2708), dependent upon the sent solution set (1902), orders (2710) for securities, and send (2712) the orders for securities to markets (2714).

20 In a further embodiment, shown in Figure 28, the client (1930) comprises more than one automated system (2804) for trading securities, and the automated systems for trading securities are scaled (2806, 2808, 2810). "Scaled" means that solutions provided to clients are apportioned for efficiency among more than one client computer system. In the embodiment shown in Figure 28, for example, solutions for symbols beginning with the letters of the alphabet between "A" and "C" are sent to a first client system (2806), and solutions for symbols beginning with letters in other ranges are apportioned among other client systems (2808, 2810).

In a further embodiment, shown in Figure 26, the computer processor is programmed also to record (2624) in the solution set (1902), as shown in more detail in Figure 29, the solution side (1916) derived from the quote side (2012), the solution MPID (1918) derived from the quote MPID (2010), the solution price (1920) derived from the quote price (2006), and the solution symbol (1908) derived from the symbol (2004) in the level-
5 two quote. In a further embodiment, as shown in Figure 26, the processor is further programmed to calculate (2626) the solution quantity dependent upon the quote and dependent upon a hidden quantity ratio (2628). The processor in this embodiment is programmed also to record (2624) the solution quantity in the solution record (2628).

10 In a further embodiment, illustrated in Figure 23, the hidden quantity ratio (2016) comprises a running average (2302) of the ratios (2304) of order fill quantity (2316) to quote quantity (2318), the order fill quantity and the quote quantity being derived from trade data (2322) comprising descriptions of executions of orders for securities having
15 structure shown at 2322 in Fig. 23. In a still further embodiment, also illustrated in Figure 23, the hidden quantity ratio (2016) comprises a ratio (2304) of an order fill quantity (2316) to a quote quantity (2318), the order fill quantity and the quote quantity being derived from trade data (2322) comprising descriptions of executions of orders for securities.

20 In a further embodiment, shown in Figure 26, the solution set includes at least two solution (2628) records, the processor (2604) being further programmed to sort (2630) the solution records (2628) to yield a sorted solution set (2632). In a further embodiment, also shown in Figure 26, the processor is further programmed to sort the
25 solution records according to side. In other embodiments, the processor is programmed to sort the solution records according to price, latency, price and latency, or side and price and latency. Other embodiments use other sorting arrangements, all of which are well within the scope of the invention.

In a further embodiment, shown in Figure 26, the processor is further programmed to delete (2636) solution latency from the sorted solution records (2632). In a further embodiment, illustrated in Figure 26A, the processor (2604) is further programmed to create (2634) an index (2634) from the solution records (2628) in the solution set (1902) for use in improved access (2642) to the solution records (2628). Indexes so created are ordered, in various alternative embodiments, according to side, price, latency, price and latency, side and price and latency, and other ordering principles. These, as well as all other arrangements of indexes for improving access to the solution records, in various alternative embodiments, are well within the scope of the invention.

In a further embodiment, illustrated in Figure 26, the solution record (1906) further includes a type code (1926). In many embodiments, the type code (1926) is used to select among computer program subroutines to vary the function of the invention to provide solutions optimizing speed of order execution, solutions optimizing price, solution optimizing quantities of securities traded, and quantities optimizing other parameters of performance. Many such solutions are effected by use of various sorting principles applied to solution records in computer memory.

In a further embodiment, shown in Figure 20A, latency comprises the difference between the time when a broker-dealer receives from a market a response to an order and the time when the order was sent to the market. Other embodiments measure latency according to the time for the order to travel from the broker-dealer to the market. Other embodiments measure latency according to the fill time within the market. All measures of latency as used in various embodiments are well within the scope of the invention.

An example of operation of the invention as a system for trading securities is the following. Assume that a reference table contains the following information regarding latency and hidden quantity ratios of markets.

Reference Table		
MPID	LATENCY	HQR
MSCO	SN	0.50
ISLD	52	1.50
INCA	475	1.25
GSCO	SN	0.75
MADF	SN	0.75
ARCA	385	1
SN	3500	NA

In most embodiments, MPIDs in the table will represent all currently-active markets. Note that all market makers will receive any orders sent them either through SelectNet or SOES and therefore must use the execution speed of those systems.

5

Upon receiving the following level-two quote the system will create the following solution record. Only the bid side is illustrated. The solution record as illustrated is already sorted according to price.

10

Level-Two Quote (Bid)		
Bid MPID	Bid Price	Bid Quantity
MSCO	99	1
GSCO	99	2
ISLD	99	1
MADF	98	10
ARCA	98	8
INCA	98	7

Sorting according to price and latency produces the following form of solution.

Solution (Bid Side Only)		
MPID	<u>Price</u>	<u>Quantity</u>
ISLD	99	1
MSCO	99	1
GSCO	99	2
ARCA	98	8
INCA	98	7
MADF	98	10

Calculating a calculated quantity dependent upon bid quantity and hidden quantity ratio is illustrated in the following table:

Bid MPID	Bid Price	Bid Quantity	<u>HQR</u>	Calculated Quantity	Market Adjusted Quantity
ISLD	99	1	1.50	1.5	1.5
MSCO	99	1	0.50	0.5	1
GSCO	99	2	0.75	1.5	1.5
ARCA	98	8	1	8	8
INCA	98	7	1.25	8.75	8.75
MADF	98	10	0.75	7.5	7.5

5

Market Adjusted Quantity is the result of applying market rules to the calculated quantity. For example, orders through SelectNet must be for at least 100 shares, and some markets have rules for preferencing market participants who are not currently priced at the inside price. Note that in this example embodiment, calculating the calculated quantity can be done before or after sorting the solution records.

10

In many embodiments, determination will be made for each market whether to use the calculated quantity or the quoted quantity. Because ECN quotes are usually representations of actual orders, ECN quotes are relatively firm. However, many ECNs support forms of hidden orders. Even for ECN's, therefore, there is often opportunity to execute quantities larger than their respective quoted quantities. In this example, it is

15

determined that the opportunity to execute against hidden orders in ISLD,ARCA and INCA is significant and the calculated quantity is used, resulting in the following solution, dependent upon the liquidity (quoted quantity) of the stock.

5

Solution (Bid Side Only)		
MPID	<u>Price</u>	<u>Quantity</u>
ISLD	99	1.5
GSCO	99	2
MSCO	99	1
INCA	98	8.75
ARCA	98	8
MADF	98	10
BBO	99	1.5

This solution in this example is provided to at least one client. If the client is an automated system for trading securities, the example processing continues as follows. Assume that the offer side of the current pertinent level-two quote is the following:

10

Level-Two Quote (for a security represented by a symbol)	
<u>Quantity</u>	<u>Price</u>
1000	98 ½
5000	99

On that assumption, use of the new solution in the embodiment under discussion would cause the following orders to be generated in response to a customer order to sell 1000 shares, trading 1000 shares at 98 ½ as follows:

15

Orders					
MPID	Side	Quantity	Price	Via	Price Improve-

					ment
ISLD	S	150	99		½
GSCO	S	200	99	SOES	½
MSCO	S	100	99	SOES	½
INCA	S	550	99		½

After these trades are executed, the remaining offer side of the current level-two quote is 5000 shares at \$99.00. The remaining unused records on the bid side of the solution set would be:

5

Solution (Bid Side Only) (remaining unused solution records)		
MPID	<u>Price</u>	<u>Quantity</u>
INCA	98	3.75
ARCA	98	8
MADF	98	10

The “used” solution records are removed in this example embodiment to avoid sending new orders to markets that may no longer have sufficient quantity to fill orders. Sending orders to markets with increased risk of failure to fill is potentially costly in terms of overall execution time for customers’ orders. In this example it is useful to note that the used solution record for the Island ECN (MPID = ISLD) was deleted from the set of solution records remaining after the trade. The ISLD solution record was deleted despite the fact that ISLD shows an hidden quantity ratio of 1.5, indicating that ISLD may fill orders for quantities substantially larger than ISLD’s quoted quantities for a security, therefore identifying ISLD as a natural trader, in this case a natural seller, of the subject securities. Nevertheless, many such embodiments will delete the ISLD solution record after using it to develop an order because it may not be possible to know or infer whether ISLD will continue to sell securities at the previous quoted price. Continuing to order at that price might risk a time-consuming order round trip, rejection for nothing. In such embodiments, the system waits for ISLD to refresh its quote and uses the new quote price

with the quote quantity and the hidden quantity ratio to generate a new solution record for ISLD. This approach addresses the problem of hidden liquidity by use of the hidden quantity ratio on a new quote, rather than by leaving the ISLD solution record in the solution set in reliance on the previous quote.

5

Turning now to Figure 30, an additional aspect of the invention is seen, that is, a method (3002) of creating an improved level-two quote. One embodiment shown in Figure 30 includes receiving (3006) in an automated system (3004), which system comprises at least one computer processor (3008) coupled to computer memory (3010), a level-two
10 quote (3012), the level-two quote comprising a data format further comprising a symbol (3014) and at least one market participant quote (3016), the market participant quote further comprising a quote price (3018), a quote quantity (3020), a quote MPID (3022), and a quote side (3024).

15 The first embodiment illustrated in Figure 30 also includes creating (3026) in computer memory (3010) an improved level-two quote (3028) comprising a symbol (3014) and at least one improved market participant quote (3030), which improved market participant quote comprises a side (3032), an MPID (3034), a price (3036), a quantity (3038) dependent upon the market participant quote quantity (3020) and also dependent upon a
20 hidden quantity ratio (3042). An additional embodiment shown on Figure 30 provides in the improved market participant quote a latency (3046), the latency comprising a latency for the market identified by the MPID (3034).

A further embodiment shown in Figure 30 includes the improved level-two quote (3028)
25 comprising at least two improved market participant quotes (3030) wherein the improved market participant quotes are sorted (3044). Some embodiments sort according to side. Other embodiments sort according to price, latency, price and latency, or side and price and latency. Still other embodiments utilize other sorting principles, all sorting

arrangement being well within the scope of the invention.

The illustrated embodiments of Figure 30 include providing (3052) the improved level-
two quotes (3028) to clients (3050), including providing the improved level-two quote to
5 clients in the form of streaming serial data provided to clients by use of suitable means
for data communications (3048). Suitable means for data communications, useful in
various embodiments, includes networks, dedicated satellite channels, dedicated
telephone lines, and the like. Any form of data communications adapted to stream data in
the form of level-two quotes is well within the scope of the invention. In addition to
10 other data elements comprising an improved level-two quote, some embodiments make
available to clients for display, or for other uses, at least one indication of hidden
liquidity, such as, for example, a hidden quantity ratio. The improved level-two quotes
are provided to clients for use in trading, investment decision-making, or for display at
the client's option. Clients for the invention include market participants, electronic
15 market participants, investors, traders, institutions, market makers, ECNs, websites, web
pages, broadcast or cable television channels, and any other clients interested in
streaming market data.